CLASSIFICATION CONFIDENTIAL **CONFIDENTIAL**

CENTRAL INTELLIGENCE AGENCY
INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT [redacted]
CD NO.

50X1-HUM

COUNTRY	USSR	DATE OF INFORMATION	1950
SUBJECT	Scientific - Aeronautics, thermodynamics		
HOW PUBLISHED	Thrice-monthly periodical	DATE DIST.	21 Nov 1950
WHERE PUBLISHED	Moscow	NO. OF PAGES	2
DATE PUBLISHED	1 Aug 1950		
LANGUAGE	Russian	SUPPLEMENT TO REPORT	[redacted]

50X1-HUM

THIS IS UNEVALUATED INFORMATION

SOURCE Doklady Akademii Nauk SSSR, Vol LXXIII, No 4, 1950, pp 671-674.

FLOW OF A GAS THROUGH A CYLINDRICAL PIPE IN THE CASE OF HEATING AND PRESENCE OF FRICTION

A. L. Klyachkin
Submitted by Acad S. A. Khristianovich
25 May 1950

/In this article of which the following is a digest the author employs a new thermodynamic criterion c/b and reveals the conditions governing the reversible conversion of heat of friction into kinetic energy of the gas. He notes that studies should be made on the influence of external heating upon the coefficient of friction./

The author considers the case of a cylindrical pipe with heat sources distributed along its length according to a linear law: $Q_v = qx$ where q is a constant in cal/kg. It is assumed that λ, the coefficient of resistance (friction), is constant and independent of Mach number and Reynolds number, M and Re.

The differential equation of subject flow with the above "linear" heating is set up:

$$(w^2 - a^2)dw/w = - gkdL_r - gdQ_v(k-1)/A$$

where $dL_r = \lambda w^2 dx/2gD$ and $a^2 = kgRT$.

From this and the energy equation is found a complicated function $w = f(M)$, involving known parameters of the gas at the pipe's input. It turns out that the parameters occurred "lumped" in a certain ratio

$$c/b = \frac{k-1}{A} gq/\frac{k\lambda}{2D} = \frac{k-1}{k} \frac{dQ_v}{dQ_r} \frac{w^2}{2g}.$$

This new parameter c/b obviously characterizes the ratio of externally-supplied heat to the heat of friction. The larger c/b, the relatively larger the amount of externally supplied heat; the smaller c/b, the larger the role of friction in the process. To $c/b = \infty$ corresponds flow with heating without friction; to $c/b = 0$ corresponds flow with friction without heating.

CLASSIFICATION CONFIDENTIAL **CONFIDENTIAL**

STATE	X	NAVY	X	NSRB		DISTRIBUTION
ARMY	X	AIR	X	FBI		

Next, the functions T(M), p(M), Q_v(M), $\lambda \frac{x}{D}$(M) are expressed analytically. Their graphs and that of w = f(M) are drawn and analyzed, to permit the following conclusions:

1. The presence of friction during "linear" heating increases the pressure drop (P_2/P_1, according to the graph of p(M)). With decreasing c/b the pressure drop becomes more intense and reaches a maximum at c/b = 0. The influence of friction upon pressure drop is more intense for large M's.

2. For acceleration [literally "starting"] of flow, friction decreases w_2/w_1 for given M; here friction's influence is relatively stronger for large M.

3. Friction decreases the quantity of heat required to reach the limiting stage (M = 1).

4. The limiting length of the tube is involved thus: the limiting value of $\lambda x/D$ (corresponding to $M_2 = 1$) increases for decreasing c/b and reaches a maximum for c/b = 0.

5. The limiting stage of flow occurs at M = 1 for any λ , $q > 0$; here the "local" index of polytropy becomes n = k (M^2 and 1/k have the same units).

6. The process of friction in the limiting state proceeds isentropically along the reverse adiabatic, which means that the heat of friction is completely converted reversibly [literally "back"] into the kinetic energy of flow.

- E N D -